Stroboscopic Method for Dynamic Imaging in a Transmission Electron Microscope at GHz Frequencies

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The official link for this solicitation is: http://www.grants.gov/web/grants/view-opportunity.html?oppId=275010

Agency:
Department of Commerce

Release Date:
March 09, 2015
Branch:
n/a

Open Date:
March 09, 2015
Program / Phase / Year:
SBIR / Phase I / 2015

Application Due Date:
May 15, 2015

Solicitation:
2015-NIST-SBIR-01

Close Date:
May 15, 2015
Topic Number:
9.01.07.63-R

Description:

A large portion of the global information technology (IT) infrastructure relies on nanoscale devices operating between 1 and 5 GHz. Familiar examples are GPS (1.5 GHz), cellular and wireless communication (2.4 GHz), dynamic random access memory (DRAM, 2 GHz) and computer processors (3 GHz). Although of wide-interest and the subject of many research and development efforts, the capability of directly imaging the propagating electromagnetic waves in a device is not available.

Transmission Electron Microscopy (TEM) is the gold standard technique in spatially-resolved imaging. However, dynamic events are not temporally resolved because the signals are time-averaged on the order of a second. Until recently, TEM has been ruled out as a viable time-resolved technique1, 2. If the TEM had the power to obtain nanoscale spatial resolution and collect images at high sampling rates, entirely new modes of observation and investigation will become available.

The goal of this project is to enable imaging of periodic, ultrafast phenomena at GHz frequencies and sub-nanometer spatial resolution to enable new measurements for magnetic data storage, advanced materials, electrochemical systems, and wireless communication. This goal shall be accomplished through the design and development of an electron beam modulator that can be integrated with a TEM to allow the capture of rapidly changing structures or features using stroboscopic methods.

Phase I activities and expected results:

- Demonstration of the feasibility of modulating a 200 – 300 keV electron beam either spatially or temporally at a frequency that is tunable between 1 and 10 GHz.
- Demonstration that the modified beam maintains sufficient spatial/energy coherence so that it remains useful for imaging.

Phase II activities and expected results:

- Build and test the electron modulator, working collaboratively with NIST and making use of a NIST- owned TEM as part of that collaboration, if applicable.

NIST will work collaboratively to design and develop the beam modulator concept with the awardee. The awardee shall provide expertise in constructing and testing of the device (Phase II). NIST will collaborate by integrating this device into an existing microscope.

References:

1. B. Barwick, H. S. Park, O.-H. Kwon, et al., Science 322, 1227. (2008).

2. J. S. Kim, T. LaGrange, B. W. Reed, et al., Science 321, 1472. (2008).